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I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP 9126 for a patent by OIL MALLEE COMPANY OF AUSTRALIA PTY LTD filed on 10 March 1999.

WITNESS my hand this
Twenty-second day of March 2000

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# PRIORITY DOCUMENT

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APPLICANT: Oil Mallee Company of Australia Pty Ltd

NUMBER:

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**AUSTRALIA**

**PATENTS ACT 1990**

# PROVISIONAL SPECIFICATION

FOR THE INVENTION ENTITLED:

**"TREE HARVESTING APPARATUS"**

The invention is described in the following statement:

# TREE HARVESTING APPARATUS

The present invention relates to a tree harvesting apparatus particularly suited for mounting on a vehicle to enable continuous tree harvesting.

The present invention was initially developed to attempt to provide a cost effective way for harvesting the leaves of a mallee tree for the production of mallee oil. Manual harvesting of the leaves is possible however this is seen as not economically viable. The Applicant therefore set out to develop an apparatus or machine that, in operation, could form part of a larger process culminating in the separation of the mallee leaves from the mallee tree.

It is known to harvest small trees in Europe, particularly Sweden, using a modified cane harvester made by an Australian company and modified forage harvesters made by a German company. The trees harvested are about 3 metres tall and being deciduous and cut in winter, have no leaves.

However, the range of mallee forms is difficult to handle with existing harvesters.

The cane harvester blocks up readily and the cutting mechanism is under the machine instead of out the front. It is designed to push the cane over before cutting and the cutting elements are 5 bladed discs with a very aggressive chopping action.

The Claas forage harvester cuts and chips out the front, but it has a light weight agricultural chipper, it lays the trees down in front of the saws after cutting, is prone to dropping cut stems and suffers blockages with bushy forms.

In parts of Australia, mallees are harvested with flail cutters (a mower style, but heavily built) but the mallees are short and flexible so the harvester can pass over them before cutting without dislodging the stumps. As the mallees are small it is not possible to travel fast enough to harvest a practical amount per hour and harvest costs per tonne are high.

According to the present invention there is provided a tree harvesting apparatus adapted for mounting on a vehicle to effect continuous tree harvesting, said apparatus including:

a rotary saw for cutting a tree near ground level;

transport means adjacent said saw for gripping a tree cut by the saw and transporting the tree to and dropping said cut tree in a chipping means located at an end of the transport means distant the rotary saw for chipping the tree;

whereby, in use, when said tree harvesting apparatus is mounted on the vehicle and said vehicle driven through a row of trees, said apparatus can continuously cut and chip said trees.

If the above apparatus is used in relation to Mallee trees, the chipped trees can then be passed through a winnowing machine to separate the leaves from the chipped wood. Oil can then be extracted from the leaves using processes that do not form part of this invention.

Preferably said saw is rotated in a direction to urge said cut tree into said transport means.

Preferably the transport means transports said cut tree in a substantially upright orientation along an inclined path to said chipping means.

Preferably the inclined path extends to one side of the vehicle to which said apparatus is mounted so that said cut trees do not substantially block the line of sight of a driver of the vehicle.

Preferably said rotary saw is a rotary circular saw and is disposed in an inclined plane so that a leading cutting edge of the saw is near ground level and below a trailing edge of the saw.

Preferably said rotary circular saw has a dished or convexly curved bottom surface

for reducing the likelihood of contact between the cutting edge of the saw and the ground.

Preferably said transport means includes first and second opposed conveyor means each provided with laterally extending fingers so that a cut tree is gripped by the fingers of the opposed conveyor means.

Preferably said first conveyor means comprises a first endless loop chain from which a plurality of said fingers extend, and said second conveyor means comprises second and third endless chains from each of which a plurality of said fingers extend, said second and third endless chains vertically spaced from each other and wherein the first endless chain is located vertically intermediate said second and third endless chains.

Preferably said second conveyor means is coupled to a floating frame that allows said second conveyor means to move relative to said first conveyor means.

Preferably said floating frame is arranged to allow said second conveyor means to fish tail.

Preferably said floating frame is further arranged to allow lateral sliding motion of said second conveyor means relative to said first conveyor means.

Preferably said chipping means is provided with a rotary chipping drum and a controllably moveable anvil adjacent said chipping drum for directing a cut tree entering said chipping means onto said chipping drum, whereby, in use, the position of the anvil can be varied to vary the angle of incidence of the tree onto the chipping drum.

Preferably said apparatus further includes height adjusting means for adjusting the height of said saw above the preferred level.

An embodiment of the present invention will now be described by way of example only with reference to the accompanying figures in which:

Figure 1 is a copy of a photograph of an embodiment of the tree harvesting apparatus mounted on a tractor;

Figure 2 is a schematic representation from the side of a rotary circular saw incorporated in the apparatus shown in Figure 1;

Figure 3 is a top view of the saw shown in Figure 2;

Figure 4 is a schematic representation in plan view of an elevator incorporated in the apparatus shown in Figure 1;

Figure 5 is a side view of the elevator shown in Figure 4;

Figure 6 is a schematic representation in plan view of a supporting frame for the elevator shown in Figures 4 and 5;

Figures 7, 8 & 9 illustrate various configurations of the frame shown in Figure 6 when the apparatus is in use;

Figure 10 is a partial schematic representation of a chipper incorporated in the apparatus when in a first configuration; and,

Figure 11 is a partial schematic representation of the chipper in a second configuration.

Referring to Figure 1, a tree harvesting apparatus 10 in accordance with an embodiment of this invention is shown mounted on the front of a vehicle in the form of tractor 12. The tree harvesting apparatus 10 includes a rotary circular saw 14 for cutting a tree near ground level, a transport means 16 adjacent the saw 14 for

gripping a tree cut by the saw 14 and transporting the tree to, and dropping the cut tree in, a chipping means in the form of a chipper 18 located at an end of the transport means 16 distant the rotary saw 14. The tree harvesting apparatus 10 mounted on the tractor 12 can be driven through a row of trees to effect continuous tree harvesting in which the saw 14 initially cuts the tree near ground level, the transport means 16 transports the cut tree to, and drops it in, the chipper 18 which chips the trees. Essentially the whole of the tree is chipped including branches and leaves. The chipper 18 has a chute 20 for ejecting the chips into a collection bag or bin towed or otherwise carried by the tractor 12. When the apparatus 10 is used in relation to mallee trees, the leaves can be separated from the chipped wood of the tree by conventional means such as winnowing. From there, oil can be extracted from the leaves using known processes that do not form part of this invention.

Referring to Figures 2 and 3, it can be seen that the rotary saw 14 is a circular type saw having a plurality of teeth 22 releasable attached about the periphery of a rotary disk 24. The teeth 22 are conventional replaceable teeth. The disk 24 is attached to a shaft 26 supported about its upper and lower ends by bearings 28. A pulley 30 (refer to Figure 3) is fixed to the top of the shaft 26 and is coupled by a belt 32 to a second pulley 34 which in turn is fixed to a hydraulic motor 36. The hydraulic motor 36 is plumbed into the hydraulic system of the tractor 12. The saw 14 and hydraulic motor 36 are supported on a sub-frame 38 that in turn is mounted on the tractor 12. A guard 39 is provided over the disk 24 to ensure that the cut stem/trunk of the tree does not sit or bear on the disk 24. This reduces friction on the disk 24 thereby reducing power requirements.

As is most apparent from Figure 2, the saw 14, and in particular the saw disk 24, is disposed in an inclined plane so that a leading (cutting) edge 40 is nearest ground level and below trailing edge 42 of the saw 14. Additionally, the bottom of the circular saw 14, and more specifically the disk 24 has a dished or convexly curved bottom of the surface 44. The inclining of the saw 14 and shaping of the bottom of the surface 44 is provided to reduce the likelihood of contact between teeth 22 at the cutting edge 40 and the bottom of the surface 44 with the ground. The reasons for

this is to minimise the wear of the saw 14. The saw is rotated in a direction (in this embodiment anticlockwise) to urge the cut tree to the transporter 16.

The transport means (referred to in general as "the transporter") 16 includes first and second opposed conveyor means 46, 48, each provided with laterally extending fingers 50 so that a cut tree can be gripped by the fingers 50 of the opposed conveyors 46, 48 and subsequently transported therebetween to the chipper 18.

The first conveyor 46 is in the form of an endless loop chain 52 from which a plurality of the fingers 50 extend. The chain 52 travels around a substantially triangular path. The triangular path is formed by two idler sprockets 54 and 56 and a drive sprocket 58 that provides the drive to cause the chain 52 to travel about the triangular path.

The second conveyor 48 comprises second and third endless loop chains 60 and 62 from each of which a plurality of the fingers 50 extend. The second and third endless chains 60 and 62 are vertically spaced from each other with the first chain 52 being located vertically intermediate the chains 60 and 62 as is clearly shown in Figure 5. Both the chains 60 and 62 travel in triangular paths. The path of the chian 60 is described by idler sprockets 64 and 66 and drive sprocket 68. The triangular path of chain 62 is described by idler sprockets 70 and 72 and drive sprocket 74. Each of the triangular paths of chains 52, 60 and 62 are in inclined planes.

The drive sprockets 68 and 74 of the chains 60 and 62 are geared together in a 1 to 1 ratio by a transmission 76. Chain 52 is driven in an anticlockwise direction and chains 60 and 62 are driven in a clockwise direction so that the run 76 of chain 52, and adjacent runs 78 and 80 of chains 60 and 62 respectively are all moving in the direction from the saw 14 to the chipper 18. The region between the runs 76, 78 and 80 defines an inclined path 82 up along which a cut tree is transported prior to dropping into the chipper 18. A skid pan or base 84 is formed underneath the path 82 to support a base of the cut tree. The shortest run 86 of chain 52 extending between idler rollers 54 and 56 converges with the shortest run 88 of chain 80

extending between idler rollers 70 an 72, and the shortest run 90 of chain 78 extending between idler rollers 64 and 66 to form a throat leading into the inclined path 82.

The first conveyor 46 is mounted on a frame 90 (refer to Figures 6-9) that in turn, is mounted to the tractor 12 via sub frame 38. The frame 90 also supports the base 84 on which the base of a cut tree can be supported while being transported up the transporter 16.

The second conveyor 48 is mounted on a floating frame 92 that in turn is supported by the tractor 12 via sub frame 38. The floating frame 92 is able to fishtail as shown in Figures 7 and 8 and also able to slide laterally as depicted in Figure 9. To facilitate this movement, the frame 92 is coupled by a variety of links to a support beam 94 that is fixed to the sub-frame 38. A bell crank 96 is pivotally coupled at each end of the support beam 94. Adjacent arms of the respective bell cranks 96 are coupled by a spring 98. The other arm of each bell crank 96 is coupled by respective first and second arms 100 and 102 to the frame 92. The arm 100 is pivotally connected at one end to its corresponding bell crank 96 and pivotally connected at its opposite end to the adjacent arm 102. The opposite end of arm 102 is fixed to the frame 92. Between each bell crank 96, there is a further link between the frame 92 and the support beam 94 provided by arms 104, 106 and 108. The arm 104 extends perpendicularly from beam 94 toward the frame 92 and is fixed at its end adjacent the beam 94. The opposite end of arm 104 is permanently coupled to arm 106. The opposite end of arm 106 is permanently coupled to one end of arm 108. The opposite end of arm 108 is fixed to the frame 92 and extends perpendicularly therefrom.

By virtue of this coupling, the frame 92 can fishtail relative to the frame 90 as depicted in Figures 7 and 8. Also, as depicted in Figure 9, the frame 92 can slide laterally of frame 90. This motion allows the floating frame 92 to move around a tree as it is transported along inclining path 82 toward the chipper 18.

The chipper 18 is in the form of a drum chipper (refer to Figures 10 and 11) having a conventional rotating chipping drum 110 provided with a cutting blade 112. The drum 110 is rotatably mounted in a chipper housing 114 which also defines the chute 20. A pair of counter rotating feed rollers 116 and 118 is provided to one side of the drum 110. A tree cut by the saw 14 and transported by the transporter 16 is dumped into the chipper 18 so that it initially passes between the counter rotating feed rollers 116 and 118 which in turn push the tree against the drum 110. The drum 110, and rollers 116 and 118 are of essentially conventional construction and form. However, the chipper 18 differs from conventional known drum chippers by the inclusion of a moveable anvil 120. Movement of the anvil 120 controls the angle of incidence of the cut tree to the drum 110. This variation in angle may be from close to square on (shown in Figure 10) where a tree extends almost radially from the drum 110 to near tangential (shown in Figure 11).

The anvil 120 is fixed to a pivot arm 122 that can be rotated about the rotational axis of the drum 110. A pair of telescopically related plates 124 and 126 extend from the anvil 120 to a point 128 located between rollers 116 and 118 but closest to roller 118. Plate 126 is pivoted at point 128 and plate 124 is pivoted adjacent the anvil 120. This allows the plates 124 and 126 to telescope toward and away from each other as the arm 122 is pivoted in the anti-clockwise and clockwise directions respectively. The plates 124 and 126 form a guide and support for the cut tree as it is being chipped by the chipping drum 110. When pivot arm 122 is pivoted in the clockwise direction, the plates 124 and 126 can be telescoped away from each other to the maximum extent as shown in Figure 11, so that they run approximately tangentially to drum 110 and roller 118. The angle of the pivot arm 122 and thus the position of the anvil 120 can be varied by use of a hydraulic or pneumatic ram or an electric screw jack, or any other conventional means. The ability to move the position of the anvil 120 and thus adjust angle of incidence of the tree to the chipping drum 110 enables the apparatus 10 to be used for a large variety of trees. This is because different trees have different physical characteristics which dictate the optimum instant angle for chipping. In particular reference to mallee trees, the provision of the adjustable chipper 18 enables highly efficient harvesting over the full

range of mallee trees as it allows separation of all leaves from the twigs whilst minimising leaf damage and producing the largest possible wood chips. These requirements work against each other. Severe chipping breaks all leaves from the twigs but also causes more leaf damage (resulting in evaporation of oil from the leaves); produces a high proportion of very small wood chips (which are difficult to separate from the leaves and are not desirable for other uses); and consumes more power from the harvester and increases chipper maintenance costs.

A typical operating cycle of the apparatus 10 will now be described.

With the apparatus 10 mounted on a tractor 12, the tractor 12 is driven along or through a row of trees (not shown). As the apparatus 10 approaches the first tree, the saw 14 cuts the trunk of the tree near ground level. It is preferred that the cut be made as close as ground level as possible but not so close so that there is contact between saw 14 and the ground. Referring to Figure 1, the saw 14 is rotated in the anti-clockwise direction so as to effectively direct the cut tree in between the first and second conveyors 46 and 48 of the transporter 16. The tree is gripped between the fingers 50 that extend from the endless chains 52, 60 and 62 and directed up the inclined path 82. The bottom of the cut tree may slide along the base 84. The tree is transported in a substantially upright or vertical orientation. When it reaches the end of the inclined path 82, it is dropped into the chipper 18. The cut end of the tree is gripped by and between the rollers 116 and 118 and forced onto the drum 110. The angle of incidence of the tree onto the drum 110 can be adjusted by pivoting the arm 122 in a clockwise or anti-clockwise to raise or lower the anvil 120. The tree is then wholly chipped with the chips ejected from the chute 20 into a container (not shown). It is envisaged that while one tree is being chipped by the chipper 18 another is being cut by the saw 14. In this way, the tractor 12 can be driven at a continuous pace through a line of trees to sequentially and continuously cut and chip the trees.

Now that an embodiment of the invention has been described in detail it will be apparent to those skilled in the relevant arts that numerous modifications and

variations may be made without departing from the basic inventive concepts. For example, the first conveyor 46 can be provided with multiple endless chains (similar to the conveyor 48). Alternatively, the first conveyor 46 can be provided with two endless chains and the second conveyor 48 provided with the single endless chian. Also, although the transporter 16 is shown as configured so as to elevate the cut tree along the inclined path 82, it is possible for the transporter to transport the cut tree without causing its elevation. However, it is preferred to elevate the trees to ensure that they do not engage the ground or any shrubs while being transported and also to reduce the overall size of the apparatus 10. Also, the apparatus 10 may be provided with means for allowing adjustment of the height of the saw 14 above the ground. This can be either a manual system such as a screw jack or an automatic system using for example, optical level sensors or strain gauges to provide a feedback signal of the distance between the saw 14 and ground level to subsequently control hydraulic rams for raising and lowering the sub-frame 38 and thus the saw 14. Additionally, the chipping drum 110 can be provided with more than a single cutting blade, with one to four blades being typical. Finally, while the preferred embodiment is described in relation to the harvesting of mallee trees, it may be used for harvesting other types of trees and bushes.

All such modifications and variations are deemed to be within the scope of the present invention, the nature of which is to be determined from the above description.

Dated this 10th day of March 1999

OIL MALLEE COMPANY OF AUSTRALIA PTY LTD
By its Patent Attorneys:

GRIFFITH HACK
Fellows Institute of Patent and
Trade Mark Attorneys of Australia.

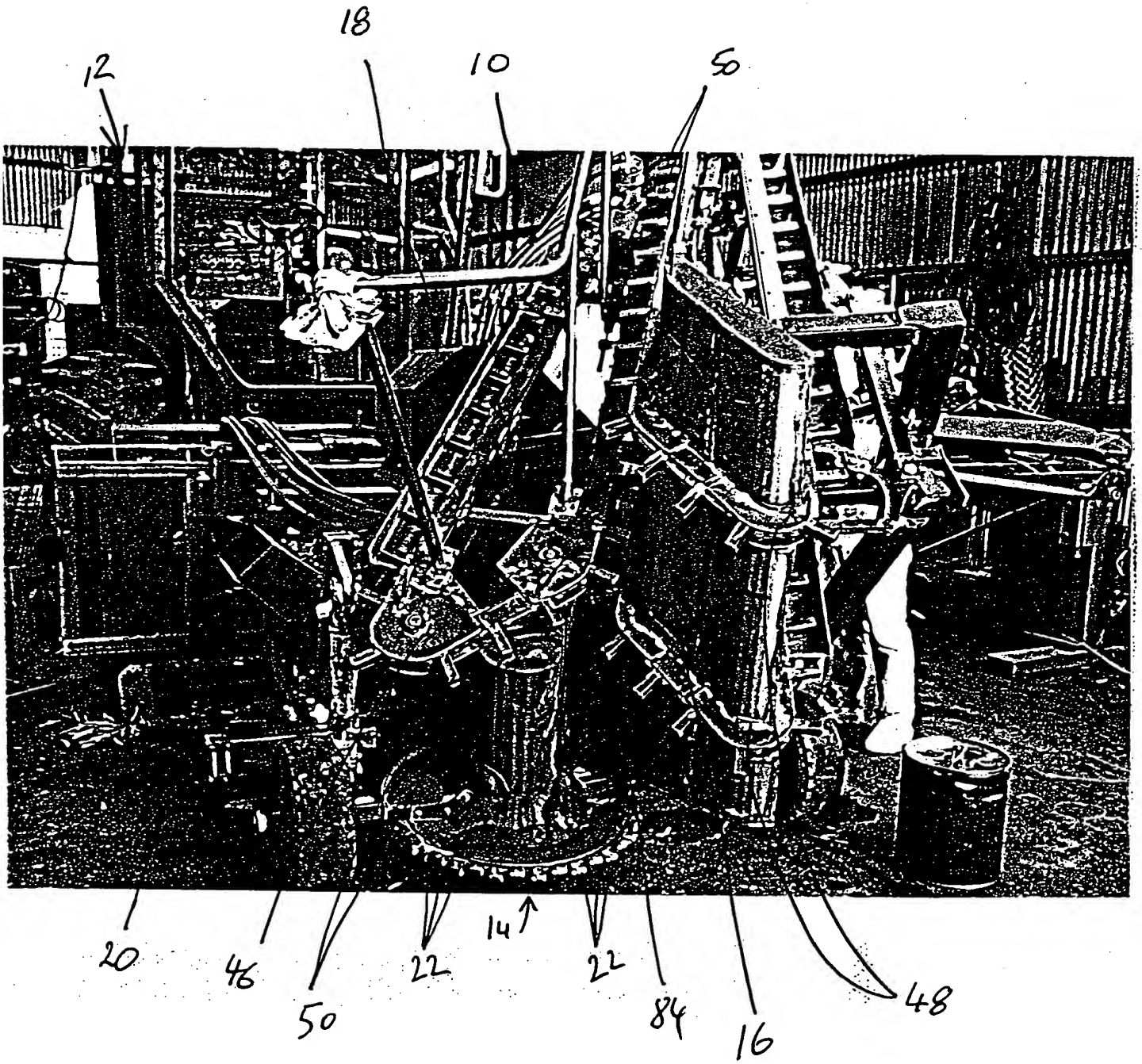



FIG 1

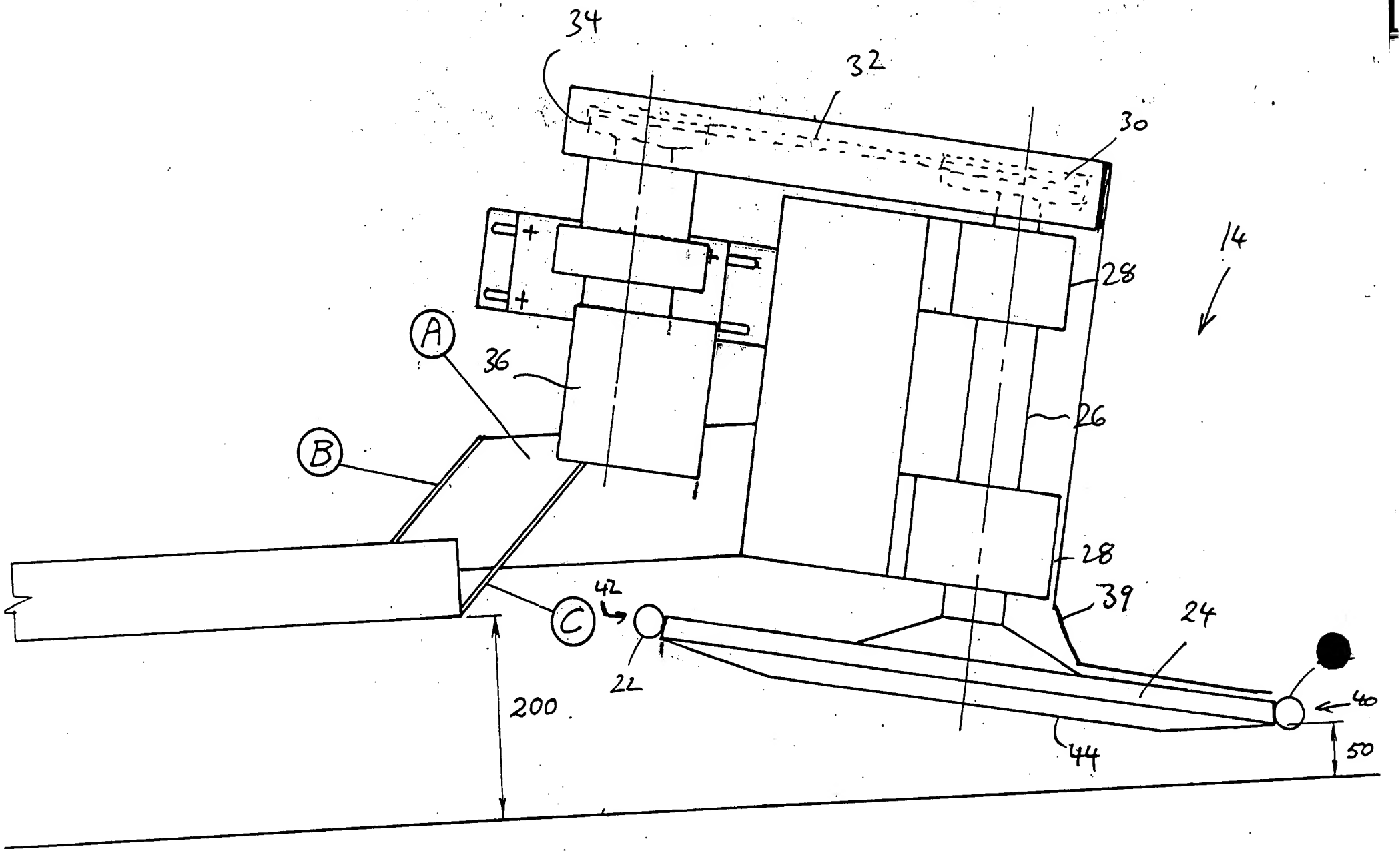



FIG 2

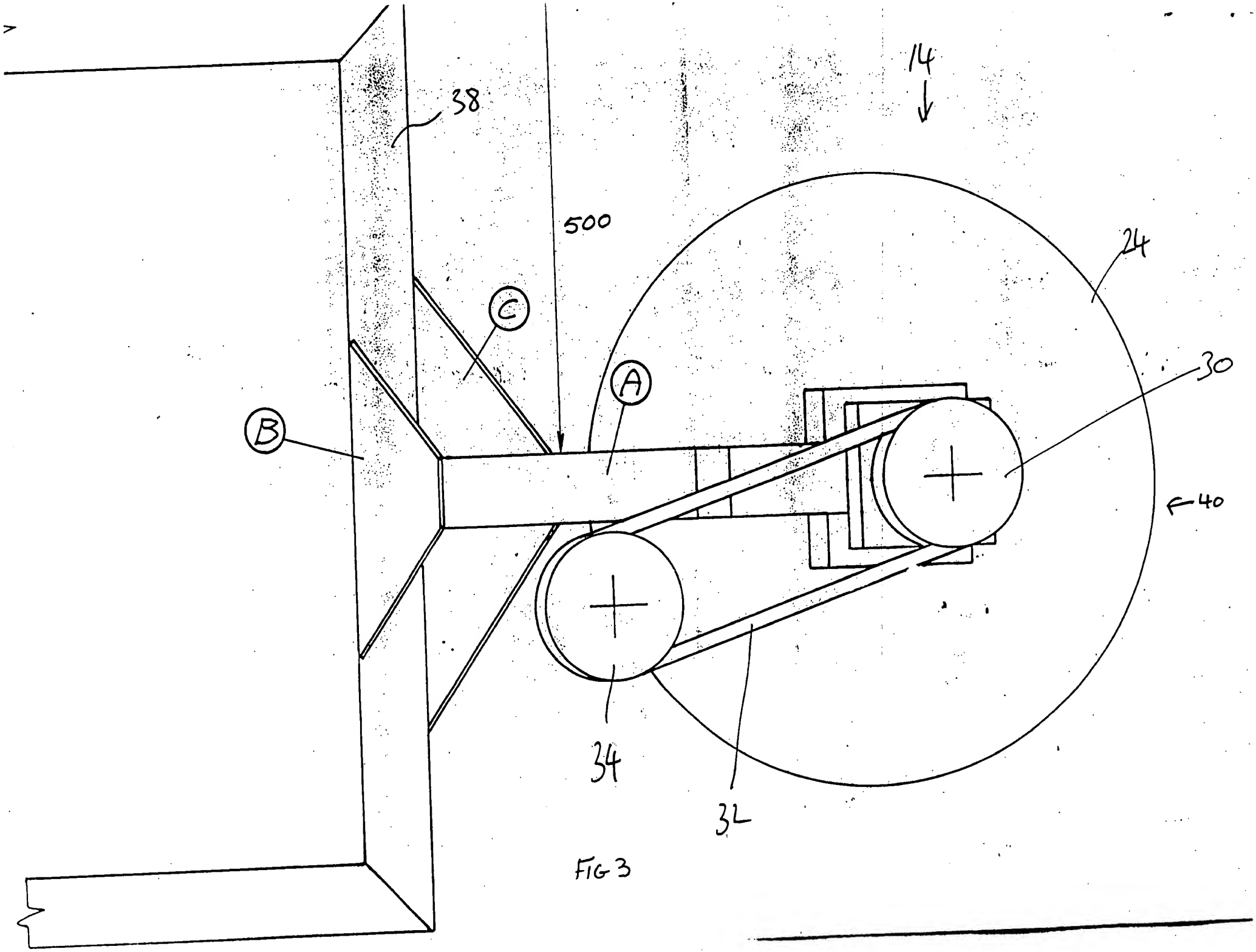



FIG 3

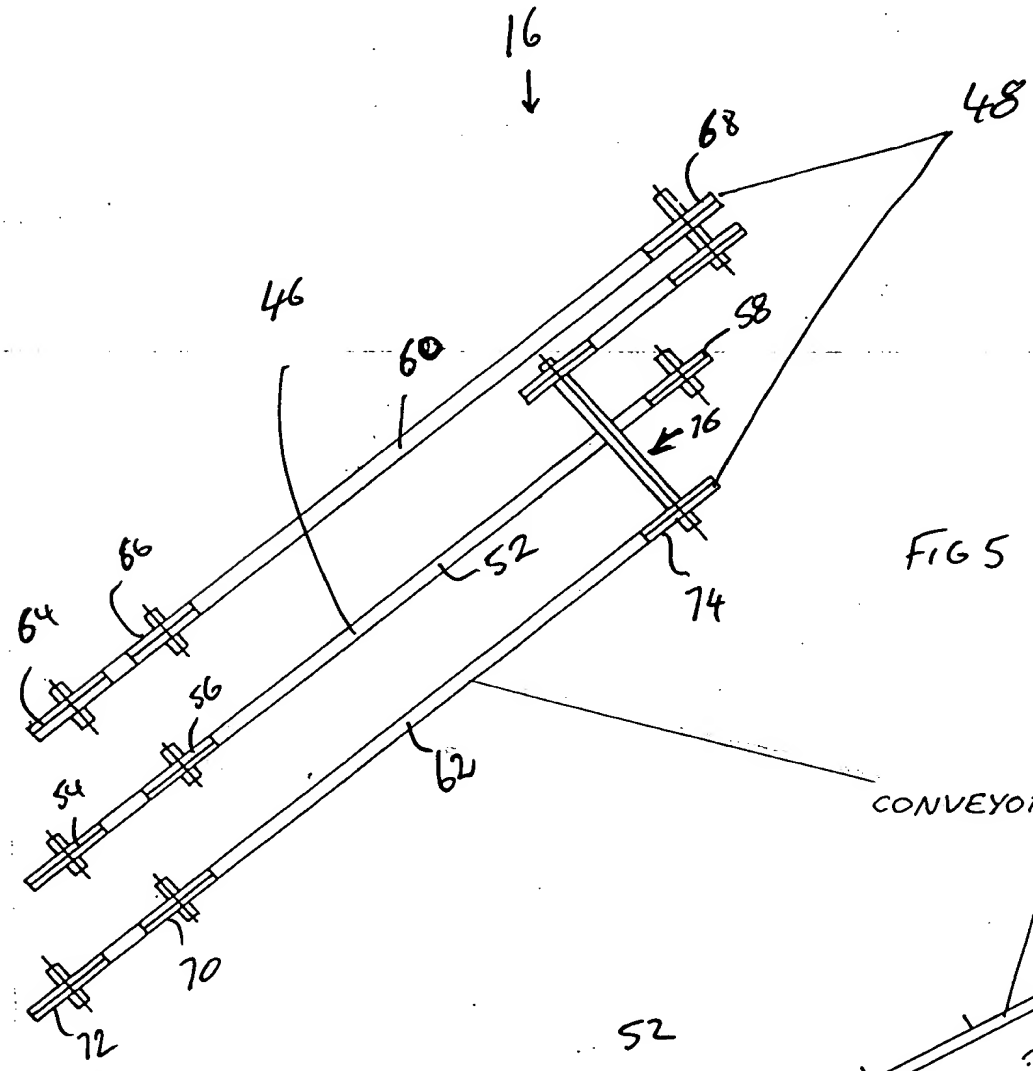

16
48
68
46
58
60
76
66
52
64
74
56
54
62
70
72

FIG 5

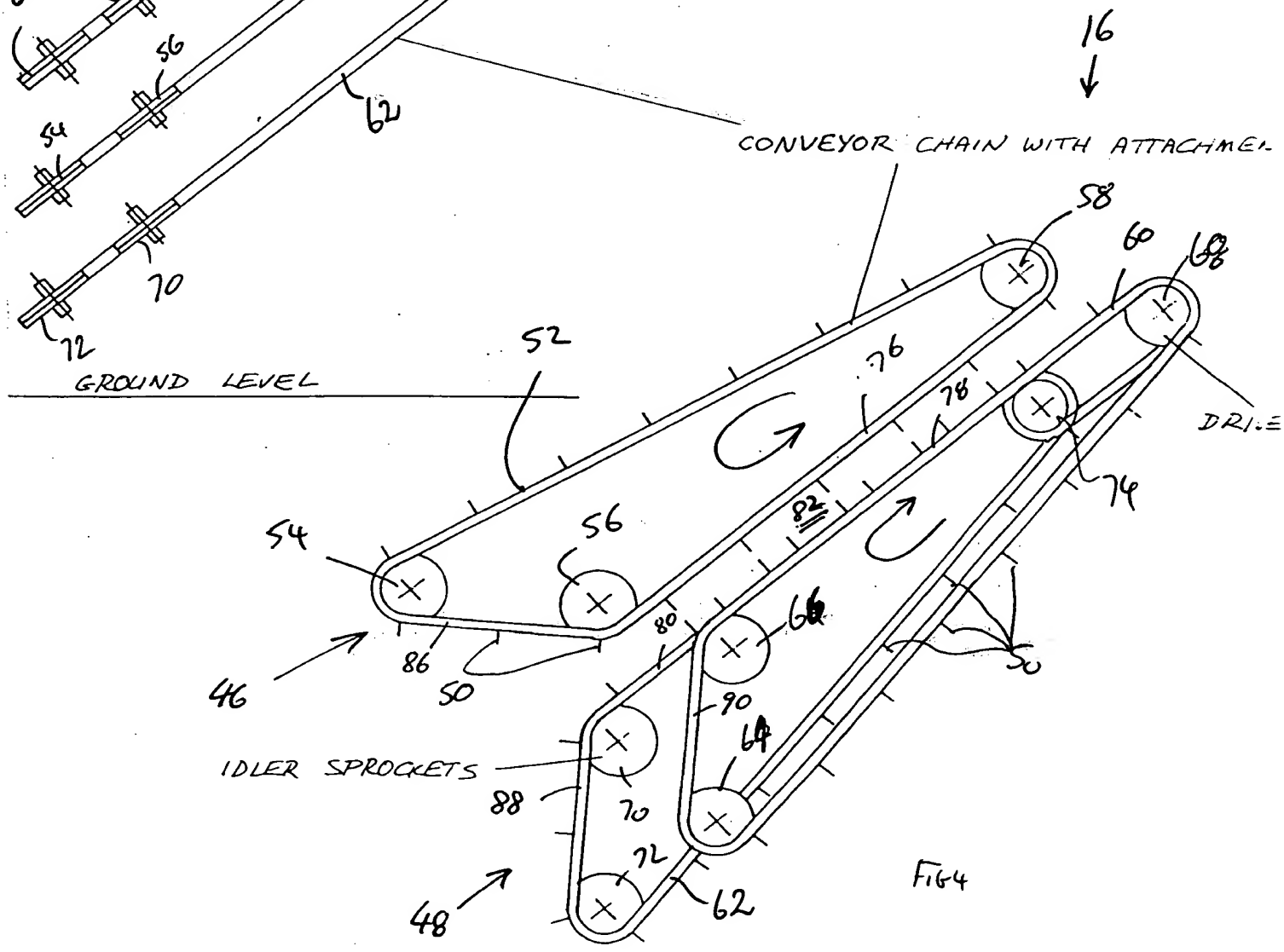
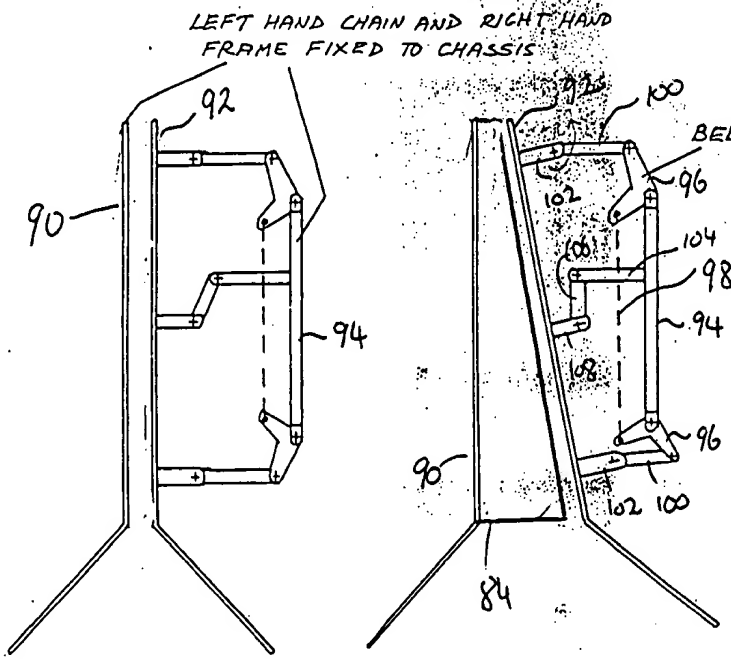
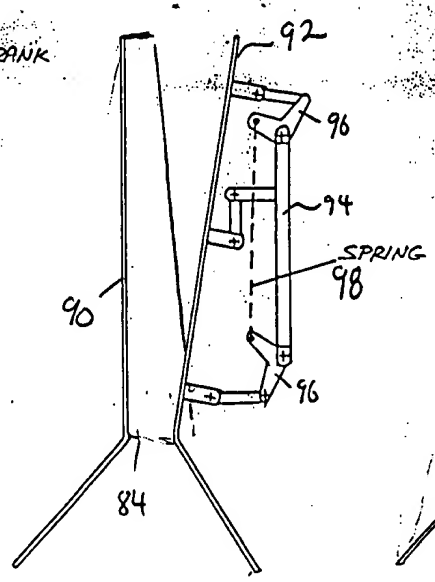

16
CONVEYOR CHAIN WITH ATTACHME
58
60
68
52
76
78
DRIVE
74
GROUND LEVEL
54
56
82
80
66
86
50
46
90
64
IDLER SPROCKETS
88
70
72
62
48

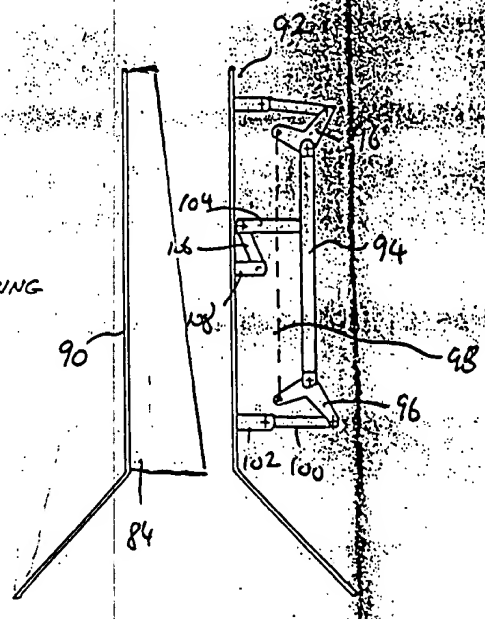
FIG 4










FLOATING FRAME FOR ELEVATOR CHAINS

FIG 6

FIG 7

FIG 8

FIG 9

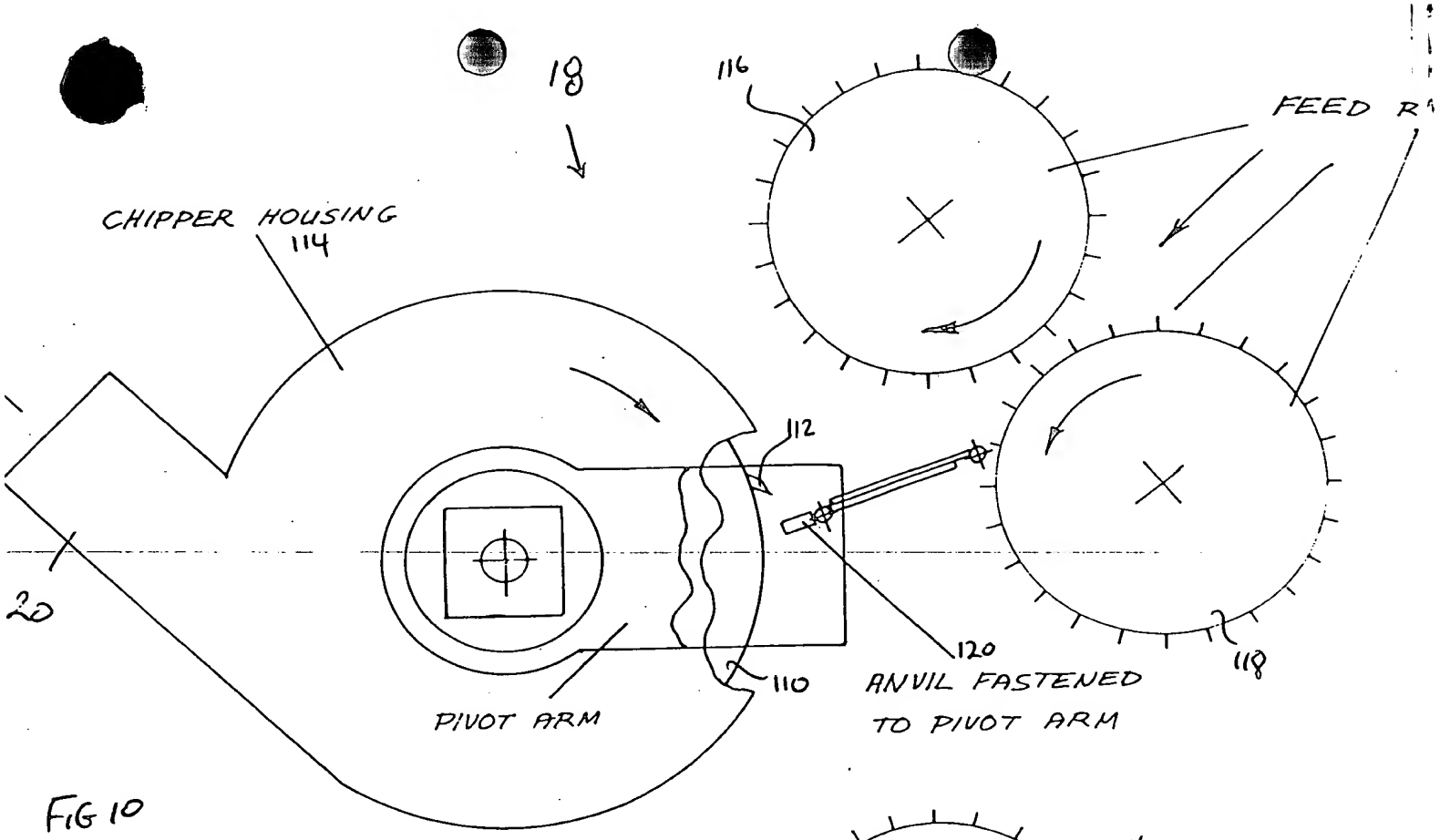
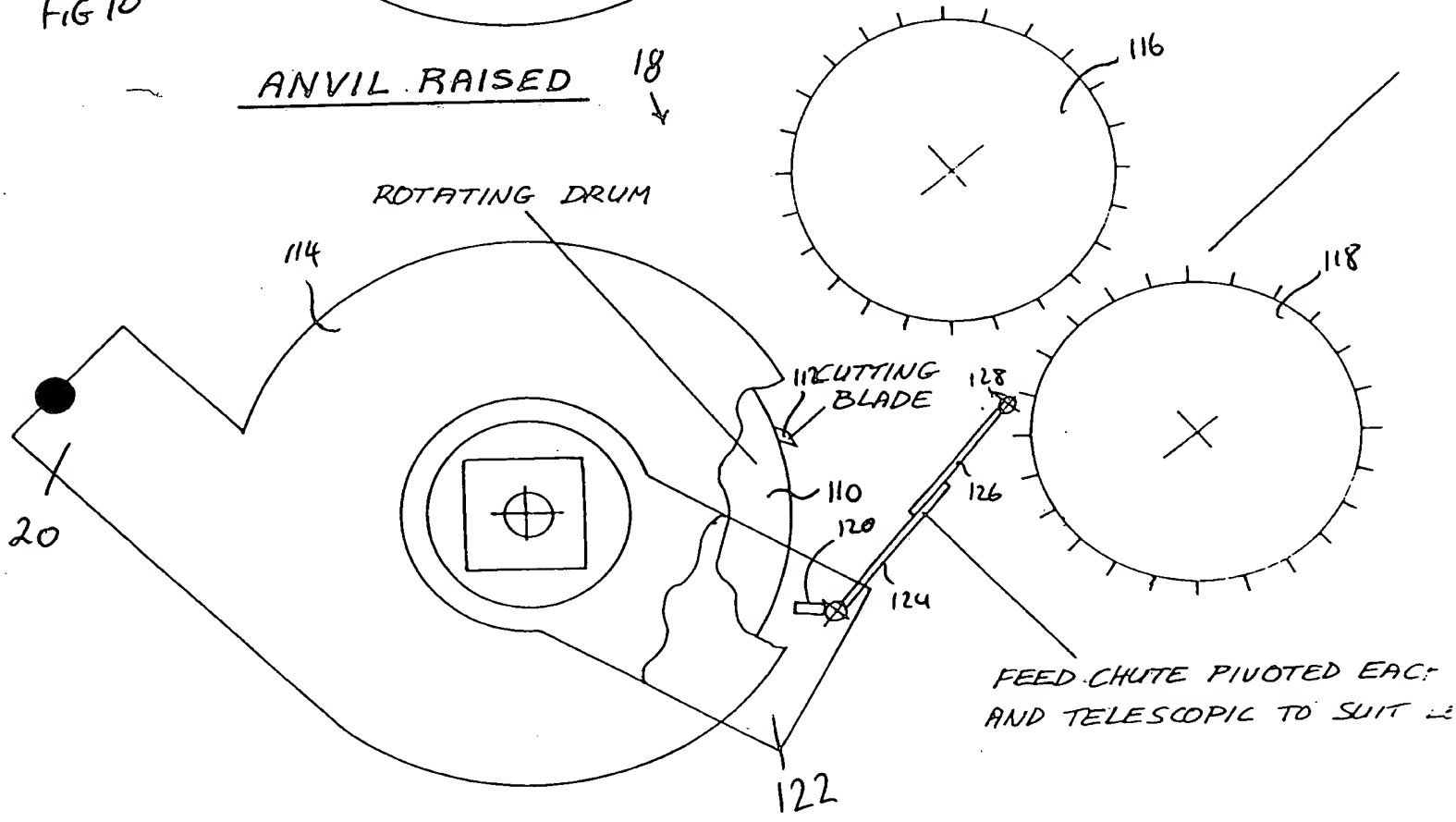



FIG 10

ANVIL RAISED




ANVIL LOWERED

FIG 11

ADJUSTABLE CUTTING ANGLE ON CHIPPER